Analysis of the Bohm criterion for two-ion-species plasmas using PARASOL

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The divertor plays essential roles in tokamak reactors for heat removal, ash exhaust, and impurity shielding. It is important to study the physics of sheath formation at a divertor plate exposed to plasmas and the interaction between plasma and wall. The Bohm criterion for a single-ion-species plasma forming a stable sheath is given by the incident ion flow velocity equal to the sound velocity. For multi-ion-species plasmas such as DT plasmas in fusion devices, however, the criterion is not still fully understood. The usual analytical procedure does not lead to a unique solution but a relation between the ion flow velocities [1]. To clarify the Bohm criterion for two-ion-species plasmas, Tskhakaya once studied it preliminarily with particle simulations taking into account all kinetic effects [2]. In the present paper, we evolutionally carry out particle simulations on this subject with a one-dimensional particle code PARASOL [3]. We found that when collisionality $L_{//}/l_{\mathrm{mfp}}$ ($L_{//}$: system size along the magnetic field, and l_{mfp}: mean free path) is low, $u_2/u_1 \approx \sqrt{m_1/m_2}$ at the entrance of magnetic presheath (u_s: ion flow velosity, m_s: ion mass and the index s represents ion species), while $u_1 = u_2$ when collisinality becomes high.

We will report the dependence of the Bohm criterion on collisionality and other plasma parameters. We will also present the peculiar sheath physics for two-ion-species plasmas.

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